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The Level of Mathematical Understanding Possessed by Prospective Elementary Teachers

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THE LEVEL OF MATHEMATICAL UNDERSTANDING POSSESSED BY PROSPECTIVE ELEMENTARY TEACHERS

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CHAPTER I

THE PROBLEM AND THE DEFINITION OF TERMS

An increasing dependence on, and influence by, science, industry, and technology exist in today's life and modern society. The essential skills and knowledge necessary for a person to understand the world in which he lives and feel at ease in modern society are steadily increasing. One of the fundamental tasks of education is to prepare individuals to meet these increasing complexities. Because mathematics has become an indispensable tool in economics, sociology, psychology, biology, and so forth, and because any area that involves rational thinking is more and more being mathematized, mathematics instruction must be at a high level throughout all years of one's formal education.

The elementary school is an integral part of the formal education structure. Mathematics instruction in the elementary school must be at an adequate level. A valuable aid in developing adequate mathematics instruction is a high level of understanding of basic mathematical concepts by the elementary teachers. Researchers have studied the teaching of mathematics in the elementary school and the level of mathematical understanding of elementary teachers for many years. The results of most studies led to statements of criticism concerning the less than adequate level of understanding of basic mathematical concepts by elementary teachers. More recently the undergraduate preparation in mathematics for prospective elementary teachers has been studied and criticized.

I. THE PROBLEM

Statement of the Problem

It was the purpose of this study to determine the level of mathematical understanding possessed by prospective elementary teachers graduating from Central Washington State College. It was also the purpose to determine if the measured level of mathematical understanding is related to such factors as sex, education classes completed, mathematics classes completed, and grade level of student teaching.

Statement of the Hypotheses

Eight null hypotheses were tested by this study. Six of the null hypotheses are that no significant difference would be found between the mean scores obtained on the advanced level of the Stanford Modern Mathematics Concepts Test for: (1) male and female prospective elementary teachers; (2) prospective elementary teachers and prospective secondary teachers; (3) prospective elementary teachers and non-mathematics, non-science prospective secondary teachers; (4) prospective elementary teachers who have taken only the required education class related to mathematics and those who have had additional education classes related to mathematics; (5) prospective elementary teachers who have taken only the required education classes related to mathematics and those who have taken additional mathematics classes from the Mathematics Department; and (6) prospective elementary teachers, kindergarten through grade three, and prospective elementary teachers, grade four through grade six, as determined by grade of

student teaching. The seventh null hypothesis was that no significant difference would be found between the mean score of prospective elementary teachers and the expected mean of beginning ninth grade students on the Stanford Modern Mathematics Concepts Test. The eighth null hypothesis tested by the study was that no significant difference would be found between the mean scores obtained from two groups of students taking the mathematics section of the education program entrance test. The two groups compared were students taking the test from fall quarter, 1963, through spring quarter, 1964, and from fall quarter, 1969, through spring quarter, 1970.

Importance of the Study

Research information of value to the classroom teacher as compiled by Suydam and Riedesel indicates that a teacher's background is related to pupil achievement and that the mathematical competency of teachers is inadequate but seems to be improving (15:642). Since pupil achievement is related to the teacher's background, a desirable goal is that the prospective elementary teacher obtain a basic level of mathematical understanding. Thus, when the prospective elementary teacher who has a working understanding of the mathematical concepts found in most elementary programs begins his first teaching assignment, the pupils are the ones who gain.

Aiding the pupil in learning is a teacher's responsibility. Aiding the prospective teacher in preparation for his role in the classroom is the responsibility of many groups, one of which is the college. Improvement of teacher preparation programs in the college is

dependent in part on the knowledge of performance by people completing the program. The preparation of mathematically competent elementary teachers graduating from Central Washington State College is desired by both the educators and mathematicians. Knowledge of the level of mathematical understanding by prospective elementary teachers graduating from Central Washington State College is of value to both the Education and Mathematics Departments in analyzing the effectiveness of present programs and classes.

Limitations of the Study

The general characteristics of the group of prospective elementary teachers graduating from Central Washington State College may not be represented by the subjects tested. The subjects tested were enrolled for summer session, 1970, and taking the class Education 490, Seminar in Education Problems. Also, the study dealt with a relatively small sample of the graduating prospective elementary teachers.

Another limiting factor was the test, the advanced level of the Stanford Modern Mathematics Concepts Test. The test was designed to measure mathematical understandings of junior-high-school-aged students. The prospective elementary teachers tested differ from junior high students in maturational level. Another difference is that junior high students are required to be taking a mathematics class, but prospective elementary teachers may not have had a mathematics class for a number of years. Maturational level and the absence of required mathematics classes may have some undetermined effect on the

performance of prospective elementary teachers on the test which has not been taken into account in this study.

The literature reviewed revealed that tests constructed for the purpose of measuring the level of mathematical understanding of elementary teachers were not in existence (10:367-371). Thus, the Stanford Modern Mathematics Concepts Test was picked as being the best tool available to the investigator despite the mentioned limitations.

II. DEFINITION OF TERMS

For the purposes of this study the following terms are defined as indicated.

Stanford Modern Mathematics Concepts Test, Advanced

This test was devised by Truman L. Kelley, Richard Madden, Eric F. Gardner, and Herbert C. Rudman in 1965 and is published by Harcourt, Brace, and World, Inc.

Cooperative Mathematics Test, Arithmetic

This test was devised by the Cooperative Test Division of the Educational Testing Service in 1962 and is published by the Educational Testing Service. The test serves as the mathematics section in the series of tests given to students seeking admission to the education program at Central Washington State College.

Prospective Elementary Teachers

The students tested were enrolled in summer session, 1970, and taking Education 490, Seminar in Education Problems, at Central

Washington State College.

CHAPTER II

REVIEW OF LITERATURE

The level of mathematical understanding of elementary teachers was a topic of much study in the late 1940's and the early 1950's. Since then this area and its related aspects have been constantly investigated.

In 1949 Glennon indicated that before trying to teach a subject a teacher must have a certain level of understanding (6:389-396). Dealing directly with elementary teachers, Newsom in 1951 and Phillips and Schaaf in 1953 found that a basic lack of understanding of mathematics existed (11:323-350; 12:48; 16:537).

Additional studies that followed during the ensuing years also reported findings that the level of mathematical understanding possessed by elementary teachers was lower than desirable. The inclusion of prospective elementary teachers added a new dimension to research studies in the area. Of the basic concepts necessary for elementary teachers to know, as agreed upon by experts, Carroll reported that elementary education students possessed few more than half of the understandings (1:494). Similarly, Reys found that the mean score by elementary education students on the algebra level of the Contemporary Mathematics Test was below the norm for ninth grade pupils (13:2927A).

After such a large number of critical studies, Sparks made the observation that most of the studies reported only deficiencies and

few reported what competencies elementary teachers and education students did possess (18:395). The fact that no tests have been developed to accurately determine the level of mathematical understanding of the elementary teachers means that less than appropriate tests have been used. This deficiency will continue until a good tool is developed with the sole purpose of testing the level of mathematical understanding of teachers (10:367-371).

The various programs of mathematical preparation for elementary education students were another aspect to be studied. The study by Williams indicated a neglect of mathematical preparation in the past and more importantly some sign of improvement (20:134A). The importance of adequate preparation in mathematics for prospective elementary teachers was stated in two recent studies. Pre-service and in-service elementary teachers were compared in both studies. The findings indicated that pre-service students in a sound program scored significantly higher on tests of basic mathematical understanding than in-service teachers, some of whom have had special workshops (3:205-208; 5:155-162). A change of instructional techniques in mathematics methods courses to present the student with situations more closely approximating what he will encounter in the classroom is a necessity indicated by Spitzer (19:137-139). An awareness by the student of his less than adequate mathematical background is the finding of a study by Reys. He concluded that over three-fourths of the graduates in elementary education were not satisfied with their mathematical preparation and desired additional training (14:190-193).

The findings in the period covering most of the past two decades

present a picture of the growing awareness of the need for sound preparation of teachers at the elementary level. Mathematics preparation of the elementary teacher has been investigated for some time. Suggestions for changing the methods of mathematics preparation for teachers are numerous. The following seems to the investigator to be an honest summation of the situation:

> Prospective elementary teachers are receiving a much more thorough mathematics training in college than was the case 10 or 15 years ago. Most new elementary teachers have a good grasp of the principles of place value, the structure of the number system, and the whole number algorithms. They have a better understanding of the rational numbers than was general in previous years, although the rational number system is not as well understood as the whole number system. Elementary teachers in general have a much better understanding of mathematics than formerly (17:152).

CHAPTER III

PROCEDURES

During the 1970 summer session at Central Washington State College nine instructors of Education 490, Seminar in Education Problems, granted permission to the investigator to administer the advanced level of the Stanford Modern Mathematics Concepts Test. The students in these classes have successfully completed student teaching. Since Education 490 is the last required class in the sequence, many of the students will graduate at the conclusion of the summer session and begin teaching in the fall of 1970. The test was administered to the students during the first three weeks of the summer session.

As part of the administration of the test the students were asked to give the following information: (1) sex; (2) approximate grade point average; (3) level and subject or grade of student teaching; (4) major field of undergraduate concentration; (5) names of high school mathematics classes completed; (6) numbers of the Education Department classes related to mathematics completed; and (7) numbers of Mathematics Department classes completed.

The Education Department requires that all students perform successfully on a series of standardized tests. One section of the series is the Cooperative Mathematics Test, arithmetic level. The mathematics test scores for the groups of students desiring entrance to the education program for two different periods of time were obtained from the Counseling and Testing Service on the Central

Washington State College campus. The scores were from the group taking the test when initially used, fall quarter, 1963, through spring quarter, 1964, and the most recent group, fall quarter, 1969, through spring quarter, 1970.

The scores of the two groups from the Cooperative Mathematics Test were compared statistically by the use of the t-test. Scores obtained from students taking the Stanford Modern Mathematics Concepts Test were separated into the various groups as indicated in the statement of hypotheses and compared statistically by the use of the t-test.

CHAPTER IV

ANALYSIS OF THE DATA AND FINDINGS

The purpose of the study was to determine the level of mathematical understanding possessed by prospective elementary teachers graduating from Central Washington State College and to determine if the level of mathematical understanding is related to such factors as sex, education classes completed, mathematics classes completed, and grade level of student teaching. These items were investigated by testing the hypotheses stated in Chapter I.

I. HYPOTHESIS 1

The statement of this hypothesis was that no significant difference would be found between the mean scores obtained by male and female prospective teachers on the Stanford Modern Mathematics Concepts Test.

The results as indicated in Table I are that male and female prospective teachers did differ significantly. The null hypothesis can be rejected at the .05 level of confidence. Male prospective elementary teachers did score significantly higher than their female counterparts. It is of value to note that all of the males tested belonged to the group of prospective intermediate teachers. The females in the group of prospective intermediate teachers had a mean score of 43.0, slightly above the males. Such a high mean by this group of females lead the investigator to discount the significance of the difference found between males and females as more indicative of a difference between students in primary and intermediate education.

TABLE I

COMPARISON OF MEANS FOR MALE AND FEMALE PROSPECTIVE ELEMENTARY TEACHERS

GROUP	N	MEAN	STANDARD DEVIATION	t
Male	10	42.60	7.37	2.080*
Female	54	35.91	9.64	

*Significant at .05 level

II. HYPOTHESIS 2

Finding no significant difference in mean scores of prospective elementary teachers and prospective secondary teachers on the Stanford Modern Mathematics Concepts Test was the statement of the second hypothesis.

The second hypothesis must be retained. Table II summarizes the results which indicate very little difference between the means of the two groups.

TABLE II

COMPARISON OF MEANS FOR PROSPECTIVE ELEMENTARY AND SECONDARY TEACHERS

GROUP	N	MEAN	STANDARD DEVIATION	t
Elementary	64	36.95	9.59	0.058*
Secondary	58	37.05	9.50	

*Not significant

III. HYPOTHESIS 3

The mean scores for prospective elementary and non-mathematics, non-science prospective secondary teachers on the Stanford Modern Mathematics Concepts Test would not differ significantly was the statement of the hypothesis.

The exclusion of mathematically oriented prospective secondary teachers appeared to have little effect on the comparison of prospective elementary to the remaining secondary teachers. No significant difference was found as indicated in Table III. The hypothesis must be retained.

TABLE III

COMPARISON OF MEANS FOR PROSPECTIVE ELEMENTARY AND NON-MATHEMATICS, NON-SCIENCE SECONDARY TEACHERS

GROUP	N	MEAN	STANDARD DEVIATION	t
Elementary	64	36.95	9.59	
Non-math/science secondary	54	36.15	8.95	0.466*

*Not significant

IV. HYPOTHESIS 4

The hypothesis was that no significant difference would be found between mean scores on the Stanford Modern Mathematics Concepts

Test for prospective elementary teachers who have taken only the required education class related to mathematics and those who have had additional education classes related to mathematics.

It was not possible to test the hypothesis because of insufficient data.

V. HYPOTHESIS 5

Finding no significant difference between the mean scores on the Stanford Modern Mathematics Concepts Test for prospective elementary teachers who have taken only the required education class related to mathematics and those who have taken additional mathematics classes was the statement of the fifth hypothesis.

Table IV reveals that a difference, significant at the .05 level of confidence, did exist between the two groups. Thus, the null hypothesis can be rejected. The additional mathematics group was limited to those students who had taken Mathematics 164.1 or 164.1 and 164.2 with no classes beyond. Mathematics 164.1 and 164.2 is an introduction to mathematics designed for prospective elementary teachers. Several of the students in this group had taken mathematics classes with a lower course number in addition to 164.1.

A composite of many factors would be necessary to explain the difference in the performance of the two groups. Some portion of the difference may be attributed to having completed Mathematics 164.1 or 164.1 and 164.2.

TABLE IV

COMPARISON OF MEANS FOR PROSPECTIVE ELEMENTARY TEACHERS WITH MINIMUM BACKGROUND AND WITH ADDITIONAL MATHEMATICS CLASSES

GROUP	N	MEAN	STANDARD DEVIATION	t
Minimum	44	34.95	8.82	2.344*
Additional	10	42.30	9.55	

*Significant at the .05 level

From Table IV it is noteworthy that only ten of sixty-four prospective elementary teachers found it possible or desirable to take the mathematics sequence designed especially for elementary education students. Also of interest is the fact that seven of the ten subjects taking additional mathematics were prospective primary teachers. A total of forty-four students had only the minimum required class related to mathematics.

VI. HYPOTHESIS 6

The mean scores on the Stanford Modern Mathematics Concepts Test for prospective primary and intermediate elementary teachers would not differ significantly was the statement of the next hypothesis.

The results indicated that prospective intermediate teachers scored significantly higher than prospective primary teachers at the .01 level of confidence. Table V indicates that the group of prospective intermediate teachers consists of twenty-one subjects of which eleven are females. Separating the intermediate group into

males and females revealed nearly identical mean scores, 43.0 for the females and 42.6 for the males.

TABLE V

COMPARISON OF MEANS FOR PROSPECTIVE PRIMARY AND INTERMEDIATE TEACHERS

GROUP	N	MEAN	STANDARD DEVIATION	t
Primary	43	34.09	9.14	3.755*
Intermediate	21	42.81	7.78	

*Significant at the .01 level

The significant difference between the two groups cannot be attributed to sex. Also the grade point averages for the two groups were approximately equal, 2.87 for the primary and 2.90 for the intermediate group. There would appear to be some characteristic of the group of prospective intermediate teachers, not considered in this study, that contributed to their significantly higher performance.

VII. HYPOTHESIS 7

The seventh hypothesis was that no significant difference would be found between the mean score of prospective elementary teachers and the expected mean of beginning ninth grade students on the Stanford Modern Mathematics Concepts Test.

Prospective elementary teachers did score significantly higher than beginning ninth grade students. Prospective elementary teachers had a mean of 36.95 as indicated in Table VI. The mean score was

compared with the ninth grade students expected mean of 33 which was taken from the manual for administration and scoring of the Stanford Modern Mathematics Concepts Test. The calculated t was significant at the .01 level. The hypothesis was rejected.

TABLE VI

COMPARISON OF THE MEAN FOR PROSPECTIVE ELEMENTARY TEACHERS AND THE EXPECTED MEAN FOR BEGINNING NINTH GRADE STUDENTS

GROUP	N	MEAN	STANDARD DEVIATION	t
Elementary Teachers	64	36.95	9.59	3.047*

*Significant at the .01 level

An analysis of the prospective elementary teachers scoring below the expected mean for ninth grade students revealed that twenty-one of the twenty-three subjects were in the group of prospective primary teachers. The mean for beginning seventh grade students is 24. Only six prospective elementary teachers, all in the primary group, scored below the seventh grade mean.

VIII. HYPOTHESIS 8

No significant difference would be found between students taking the mathematics section of the education program entrance test from fall quarter, 1963, to spring quarter, 1964, and from fall quarter, 1969, to spring quarter, 1970, was the statement of the hypothesis.

As the results of the t-test in Table VII show the two groups

did not differ significantly. The hypothesis that no difference exists between the two groups was retained. The indicated mean scores for the two groups would be located in the upper third for eighth grade students based on the information accompanying the Cooperative Mathematics Test. The mean scores also included sixteen percent of the students who failed to score above the cut-off level for entrance to the education program. Without the students failing to make the cut-off level both means would be approximately 39.3. A mean score of 39 would be in the top quarter for eighth grade students.

It would appear that incoming students in the education program have had the same level of mathematical understanding for the past eight years.

TABLE VII

COMPARISON OF MEANS FOR STUDENTS TAKING THE EDUCATION PROGRAM ENTRANCE TESTS, MATHEMATICS SECTION, IN 1963-64 AND 1969-70

GROUP	N	MEAN	STANDARD DEVIATION	t
1963-64	758	37.01	10.25	0.343*
1969-70	1281	37.13	9.30	

*Not significant

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purposes of this chapter are to summarize the findings of this study, to draw some conclusions, and to make some recommendations as a result of conducting the study. The initial chapter presented the problem and introduced the study. Chapter II provided a review of the literature. The two preceding chapters described the procedure followed and the findings.

I. SUMMARY

The purpose of the study was to determine the mathematical level of understanding of prospective elementary teachers graduating from Central Washington State College and to determine if the level of understanding is related to factors such as sex, education classes completed, mathematics classes completed, and grade level of student teaching.

Students enrolled in Education 490, Seminar in Education Problems, during the 1970 summer session were given the advanced level of the Stanford Modern Mathematics Concepts Test. Using background information given by the student, the various groups were established.

The various groups were compared statistically by the t-test. It was found that: (1) males scored significantly higher than females; (2) students with Mathematics 164.1 or 164.1 and 164.2 in their background scored significantly higher than those students taking only

the minimum education class related to mathematics; (3) prospective intermediate teachers scored significantly higher than prospective primary teachers; and (4) prospective elementary teachers scored significantly higher than the expected mean for beginning ninth grade students. No statistically significant difference was found between prospective elementary and secondary teachers. Also, students taking the mathematics section of the education program entrance tests during the 1969-70 academic year did not differ statistically from those who took the same test for the 1963-64 academic year.

II. CONCLUSIONS

Students attempting to enter the education program have shown a fairly constant level of mathematical understanding over the past eight years. Whether a student is in the elementary or secondary program, there appears to be no measureable effect on the level of mathematics understanding. The mean scores of the prospective elementary and secondary teachers were nearly identical.

As one would intuitively feel, students who had additional classes in mathematics produced significantly higher scores. Of the ten students taking additional Mathematics Department classes related to mathematics in the elementary school, seven were prospective primary teachers. These seven students represented only sixteen percent of the total number of prospective primary teachers in the sample.

In this study a respectable performance of mathematical understanding by prospective elementary teachers graduating from Central Washington State College was observed. Prospective intermediate

teachers scored at a level that the investigator feels will result in generally sound mathematical instruction in the upper elementary grades. Although prospective primary teachers were significantly outscored by the intermediate group, the results for the primary group are still encouraging. Prospective primary teachers have indicated a mathematical competency comparable to beginning ninth grade students. With some reservation it can be said that the prospective primary teacher possesses an adequate understanding of basic mathematics. As primary teachers they probably can be comfortable with most of the current primary mathematics programs.

It is necessary to mention some limitations and assumptions. The test was a factor limiting the study. The test was designed to measure junior-high-aged students. The test was not a good tool for the study; but few, if any, other tests exist that would have been better. Also, the investigator was assuming a debatable premise, that better understanding of a subject leads to better teaching of that subject.

Therefore, the conclusion is that the level of mathematical understanding of prospective elementary teachers is not deficient.

III. RECOMMENDATIONS

As a result of having conducted the study, several items are suggested by the investigator.

1. A well-designed examination of the effectiveness of Education 323, Teaching of Arithmetic, as a methods class and Mathematics 164.1 and 164.2, Introduction to Mathematics for the

Elementary Teacher, as a content class should be undertaken.

2. Prospective elementary teachers should be encouraged to take additional classes in mathematics.

3. The factors that contributed to the significantly higher performance by prospective intermediate teachers compared to prospective primary teachers should be determined.

4. Measuring the level of mathematical understanding of male primary teachers, if any can be found, would complement information obtained in the study.

5. A study of the effects that student teaching has on increasing mathematical understanding would give valuable information in relation to the preparation of elementary teachers.

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